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NESTING AND BROOD-REARING HABITAT OF LESSER PRAIRIE CHICKENS IN SOUTHEASTERN NEW MEXICO

BY

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"Nesting and Brood-rearing Habitat of Lesser Prairie Chickens in Southeastern New Mexico," a thesis prepared by Terry Zene Riley in partial fulfillment of the requirements for the degree, Master of Science, has been approved and accepted by the following:

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ABSTRACT

NESTING AND BROOD-REARING HABITAT

OF LESSER PRAIRIE CHICKENS

BY

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Master of Science in Wildlife Science

New Mexico State University

Las Cruces, New Mexico, 1978

Dr. Charles A. Davis, Chairman

Nesting and brood-rearing habitat is described for lesser prairie chickens (Tympanuchus pallidicinctus Ridgway) in Chaves County, New Mexico, from June 1976 to August 1977.

Vegetation of the study area is of 2 types, Shinnery Oak (Quercus havardi)-tallgrass and Mesquite (Prosopis juliflora)-shortgrass. Shinnery Oak-tallgrass includes 3 subtypes, with Subtype 1 having the greatest amount of grass, Subtype 3 the least.

Vertical mist nets, a cannon net and a rocket net were used to capture prairie chickens, and females were equipped with miniature radio transmitters in order to study nesting and brood-rearing habitat.

Eighteen nest sites were located. Females appeared to prefer

Subtype 1 of the Shinnery Oak-tallgrass habitat type (the most grassy areas present) for nesting habitat. No nests were found in the Mesquite-shortgrass type. More litter was present at nests than in the general area where nests were located. Nests were placed in tall vegetation within grassy depressions among low sandhills. Percent nesting success was higher in Subtype 1 than in other subtypes. In Subtypes 1 and 2, more grasses were present near successful nests than near unsuccessful nests. In Subtype 3, more shrub and less grass cover was present near the 1 successful nest than near the unsuccessful nest. Nests placed in lightly grazed or ungrazed bluestem (Andropogon spp.) clumps were more likely to be successful than those placed in cover of other plant species.

Preferred brood-rearing habitat was much less grassy, and correspondingly more brushy, than nesting habitat. Preferred brood-foraging areas were in Subtypes 2 and 3 of Shinnery Oak-tallgrass. There was no indication of brood-use in the Mesquite-shortgrass habitat type. Ground litter at brood-foraging sites was less than at nest sites. Height of vegetation at brood-foraging sites was similar to that of the general area where these sites were located. Radio-located broods foraged in areas of shorter grasses than did randomly located broods, and evening foraging sites appeared slightly more grassy than morning foraging sites.

Restoration of tallgrass habitat in the more brushy areas, especially in Subtype 3 of Shinnery Oak-tallgrass, is recommended. Plans for future development of new livestock watering facilities in the study area should be curtailed. Continued research into habitat-use

and behavior of lesser prairie chickens is needed. Population census methods should be researched to establish an accurate technique to evaluate management practices for prairie chickens.

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INTRODUCTION

During historical times, the lesser prairie chicken (*Tympanuchus pallidicinctus* Ridgway) has occupied a small geographic range (Greenway 1958). Prior to intensive settlement, the species inhabited parts of eastern New Mexico, southeastern Colorado, southwestern Kansas, western Oklahoma, and a portion of western Texas (Sharpe 1968). Numbers increased temporarily during the late nineteenth century, apparently in response to additional fall and winter food sources supplied by the patchwork type of farming which was widespread in the West at that time. Populations were very low during the great drouths of the 1930's and 1950's, probably in response to loss of suitable habitat (Donaldson 1969). Numbers and range of the lesser prairie chicken now are greatly reduced in comparison with those of pre-settlement days, apparently due to grazing and brush control in addition to the great drouths (Hamerstrom and Hamerstrom 1961).

Most of the available information on habitat of the lesser prairie chicken is of a rather general nature. Crawford (1974) found that in Yoakum County, western Texas, large areas consisting of 63 to 95 percent native shrub-grassland with the remainder in cultivation, especially grain sorgum, supported the largest populations and bird densities. Areas of 100 percent shrub-grassland were capable of supporting smaller populations, and areas of less than 63 percent shrub-grassland were incapable of sustaining populations. Crawford also found high positive correlations between lesser prairie chicken numbers and extent of sandy

areas, indicating a reliance of this bird on shinnery oak-bluestem[1] sandhills.

Habitat of lesser prairie chickens has been described by Copelin (1963:7) as ". . .a land of low to high density shrub savannah where most shrubs are three feet tall or less." Hoffman (1963), Jackson and DeArment (1963), and Jones (1963) all have stated that lesser prairie chickens need a mixture of grass and shrub types in their habitat. Hoffman (1963) and Jackson and DeArment (1963) further stated that reductions in numbers of lesser prairie chickens were due, in part, to displacement of these types by cultivation, grazing, and brush control, as well as the drouths of the 1930's and 1950's.

The New Mexico Department of Game and Fish has attempted to improve areas of lesser prairie chicken range by construction of exclosures to prevent grazing by cattle (Frary 1957). Although Hoffman (1959) called this the most important single attempt to restore lesser prairie chickens, very little research has been done in New Mexico which would serve as a basis for accurate evaluation of the effects of grazing, or of the exclusion of grazing. Frary (1957) attempted to evaluate the effects of these grazing exclosures on lesser prairie chicken populations, and to determine habitat use throughout the year, but reported few data. The exclosures were subjected to limited grazing later, after it was found that prairie chickens were using the areas outside the exclosures more frequently than inside. Two 160-acre exclosures were constructed in southeastern Colorado by the Colorado Department of Game and Fish in cooperation with the Forest

[1]Common and Latin names of plants used herein are listed in the Appendix.

Service, U. S. Department of Agriculture, primarily for restoration of nesting and brood-rearing cover (Hoffman 1961, 1963). However, very little information on the results of these exclosures was found in the literature. Many more research data are needed for identification of which habitat components are utilized by lesser prairie chickens throughout the year, so that guidelines for future grazing and agricultural practices can be formulated for areas inhabited by the species.

Bent (1932) quoted Walter Colvin's descriptions of 3 lesser prairie chicken nests found in southwestern Kansas. Two of these nests were well concealed in sand sagebrush clumps, and 1 was found under a tumbleweed which had lodged between 2 tufts of grass. Copelin (1963) reported 7 nests found in Oklahoma. All were located between clumps of grass, usually little bluestem. Jones (1963) noted that 1 nest in Oklahoma was in a half-shrub, shortgrass community. Donaldson (1969) reported on 1 nest in Oklahoma with more detail than others cited. This nest was surrounded by little bluestem and scribner's panicum near ground level, and was concealed from above by brush, principally shinnery oak. Sell and Stromborg (1976) reported cover at 4 nest sites on heavily grazed rangeland in western Texas as consisting primarily of sand sagebrush and shinnery oak.

Descriptions of vegetation at lesser prairie chicken nest sites in New Mexico have been limited to very general statements. Bailey (1928:208) stated simply that nests were ". . .in the open or among grass or weeds. . .," and Ligon (1961:92) that they were ". . .well concealed beneath rank grass or shrub, such as shinnery oak."

Habitat used by broods of lesser prairie chickens has received

little study. Jones (1963:772) found that broods in Oklahoma preferred areas ". . .dominated by shrub and half-shrub life forms. . .," principally skunk-bush and sand sagebrush, respectively, with relatively large percentages of forbs. Donaldson (1969) found that broods utilized vegetation which was low in stature and of rather open aspect for foraging.

In order to meet the need for additional information on prairie chicken habitat in New Mexico, a study was initiated with the following objectives: (1) Determine the vegetational characteristics of nesting, brood-rearing, and other seasonally occupied habitat through observation of lesser prairie chickens; and (2) develop management recommendations in terms of vegetational goals for specific habitat features, including spatial requirements of these goals, to maintain a secure population of lesser prairie chickens in the study area. Field work was conducted from February 1976, through August 1977. This thesis reports on selected aspects of the study, principally the data collected in 1977. Findings, conclusions, and recommendations contained herein are tentative and subject to modification as the study proceeds.

STUDY AREA

The study area of approximately 15,513 ha (Fig. 1) is located on national resource lands in the East Chaves Planning Unit of the Roswell, New Mexico District of the U. S. Department of Interior, Bureau of Land Management (BLM). The area is approximately 64 km east of Roswell, and lies north of U. S. Highway 380 and south of U. S. 70. Topography is gently undulating to dunelike.

Vegetation consists of 2 principal types. The Shinnery Oak-tallgrass type occurs on the deep sandy soils which occupy most of the area, and the Mesquite-shortgrass type occurs on shallower, heavier soils. These vegetation types will be described in greater detail later. The principal use of the area is for grazing by cattle.

Climate of the study area (Maker et al., 1971) is semi-arid, characterized by distinct seasons, wide ranges of diurnal and annual temperatures, moderately low rainfall, and plentiful sunshine. Temperatures of 32 degrees C or higher occur on most days from mid-May through mid-September, and temperatures above 38 degrees C are common from June through August. Nighttime temperatures generally are about 15 degrees cooler. Nearly 75 percent of the annual precipitation falls during the growing season, May through October, mainly from brief but often intense thunderstorms.

Temperatures in 1975, 1976, and 1977 at Maljamar, approximately 60 km southeast of the study area, are given in Table 1. Average monthly minima and maxima were relatively consistent from year to year, except that the average maximum temperatures were higher in July and

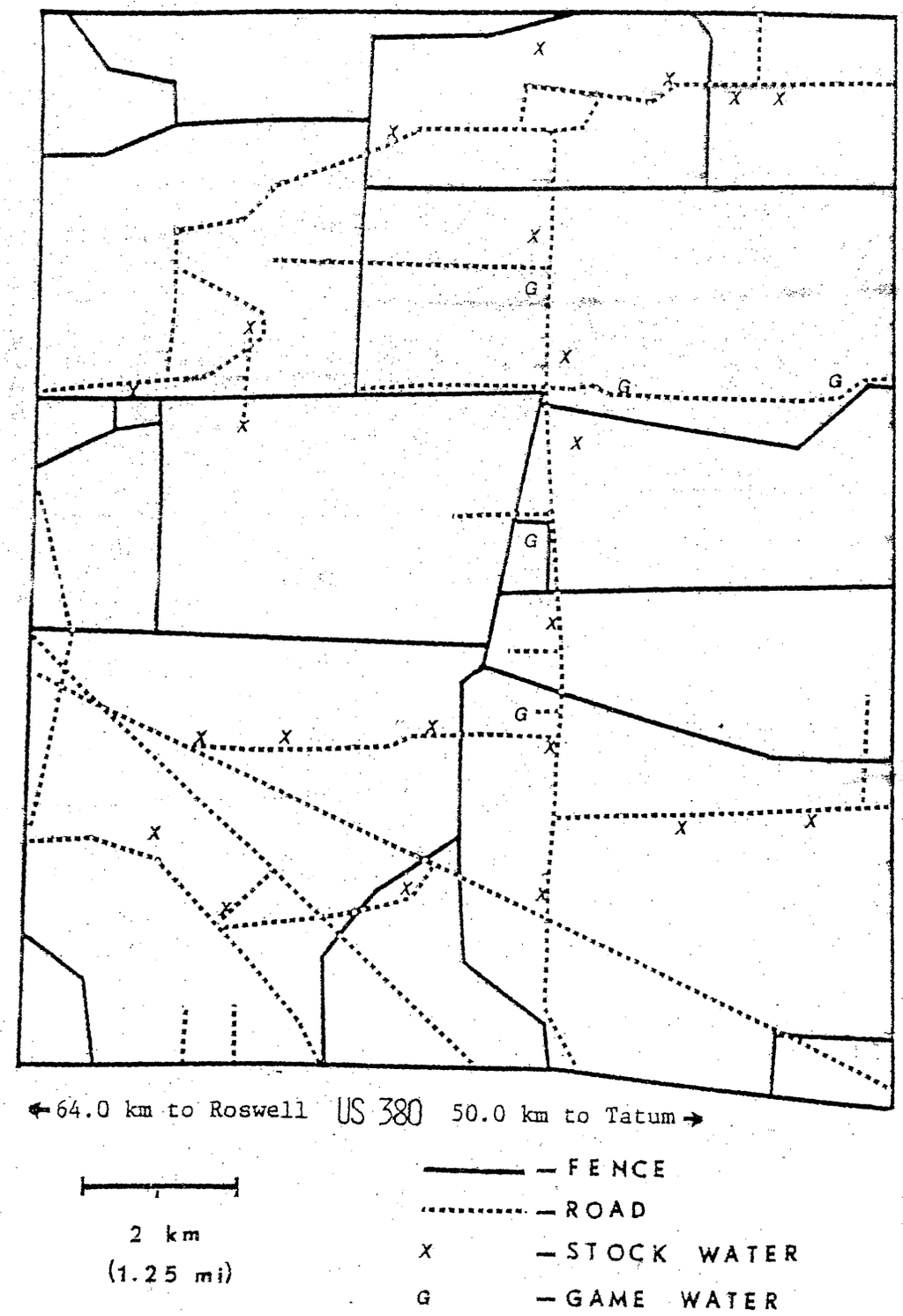


Fig. 1. Study Area

Table 1. Average monthly minimum and maximum temperatures (C), from data recorded at Maljamar, New Mexico during 1975, 1976, and 1977 (U.S. Dept. of Commerce 1975, 1976, 1977).

	1975		1976		1977	
Month	Min.	Max.	Min.	Max.	Min.	Max.
January	- 2.9	14.1	- 5.8	14.1	- 7.1	11.0
February	- 2.7	15.1	0.1	20.7	- 2.7	17.3
March	0.6	20.1	1.2	21.5	- 0.5	19.4
April	4.2	23.6	6.8	26.4	6.3	24.6
May	8.6	27.9	8.8	27.8	12.1	30.7
June	13.7	34.5	14.6	33.9	15.3	35.4
July	15.8	31.0	15.4	31.8	17.5	36.5
August	14.9	32.5	15.3	34.2	----	----
September	10.6	28.6	13.0	28.7	14.0	34.4
October	6.1	26.8	3.2	22.1	7.2	25.5
November	- 1.8	19.6	- 3.4	15.4	- 0.1	20.7
December	- 4.4	15.8	- 6.2	14.7	- 3.6	17.1

September 1977 than in other years. Precipitation data from Maljamar are given in Fig. 2. Both total amount and temporal distribution of rainfall were similar in 1975 and 1976. Spring of 1976 was somewhat drier than that of 1975 and 1977, but total amounts of precipitation in 1975 and 1976 were similar and both were near the average of approximately 38 cm. Rainfall in 1977 (24.51 cm) was lower than average, due primarily to small amounts falling during July, August, and September.

Two principal habitat types, Shinnery Oak-tallgrass and Mesquite-shortgrass, are present (Fig. 3). The 3 subtypes of Shinnery Oak-tallgrass (Table 2) are distinguished primarily by relative quantities of sand bluestem, which is the primary indicator species. It declines in quantity from Subtype 1 through Subtype 3. Somewhat the reverse is true for little bluestem and three-awns. These species represent larger percentages of the vegetation in the subtypes where sand bluestem is less abundant. Abundance of hairy grama declines from Subtype 1 to Subtype 3, like that of sand bluestem, but to a smaller degree.

The abundance of grasses in Subtypes 1 and 2 is accompanied by a relative shortage of shinnery oak. This woody species is present in greatest relative quantity in Subtype 3, where it composes a larger percentage of the vegetational composition than do grasses. Amounts of vegetational cover and ground litter in Subtype 1 are greater than in other subtypes (Table 3).

Vegetation in areas of Mesquite-shortgrass is primarily grasses. Blue grama and buffalo grass are the most common plants in this habitat type. Shrubs, primarily broom snakeweed, are present only in

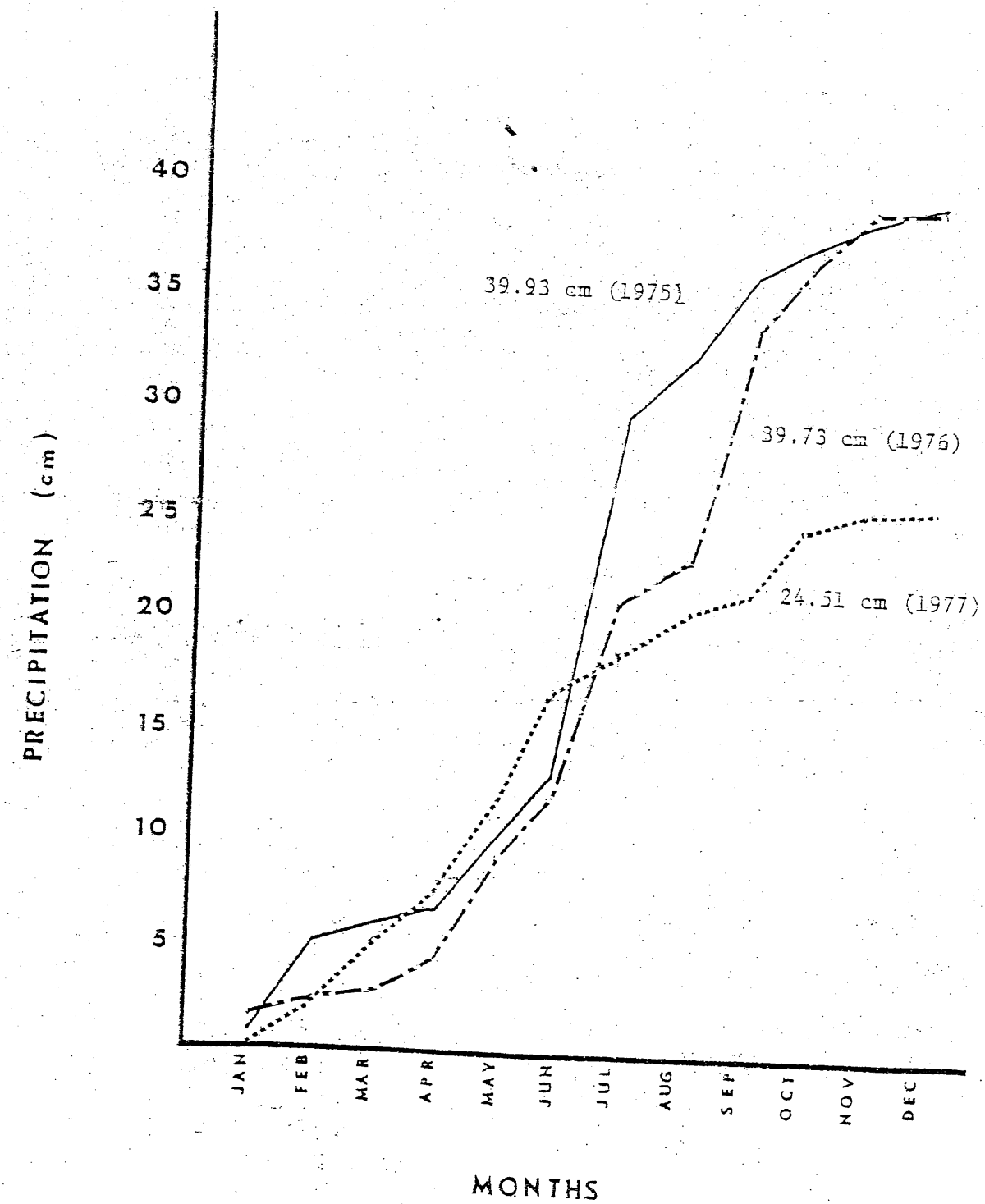
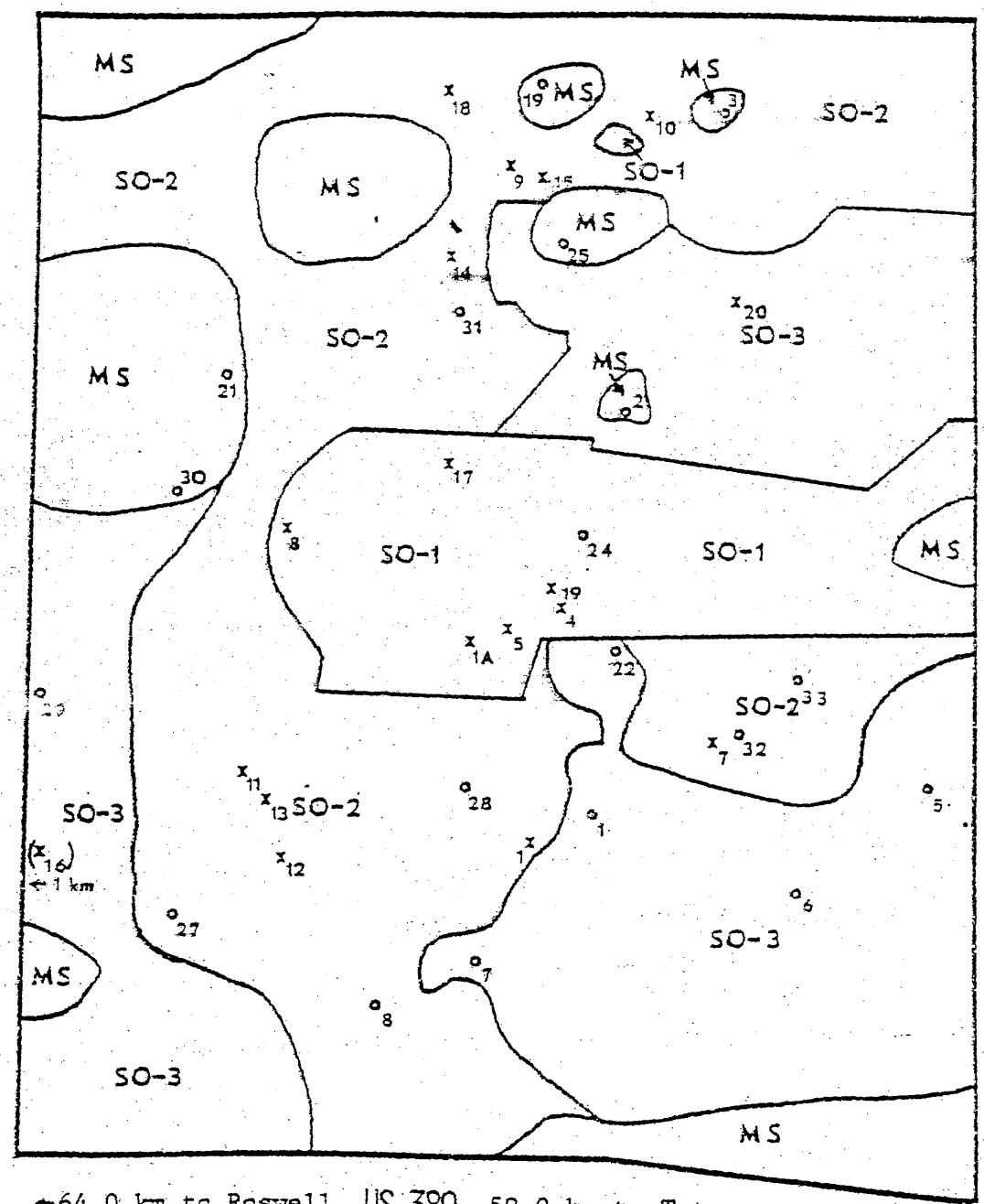


Figure 2. Cumulative precipitation at Maljamar, New Mexico (U.S. Dept. of Comm. 1975, 1976, 1977)



←64.0 km to Roswell US 380 50.0 km to Tatum→

SO-1 — SHINNERY OAK-TALLGRASS, SUBTYPE 1
SO-2 — SHINNERY OAK-TALLGRASS, SUBTYPE 2
SO-3 — SHINNERY OAK-TALLGRASS, SUBTYPE 3
MS — MESQUITE-SHORTGRASS
X — NEST SITE
O — BOOMING GROUND

2 km
(1.25 mi)

Fig. 3. Habitat types and subtypes on study area.

Table 2. Percent basal composition of vegetation in the Shinnery Oak-tallgrass habitat subtypes.

Species	Subtype 1 (30)[a]	Subtype 2 (60)	Subtype 3 (32)
Grasses			
Sand bluestem	26.8 ± 6.1[b]	8.5 ± 5.6	5.0 ± 5.1
Three-awns	7.6 ± 2.8	16.7 ± 5.2	13.3 ± 4.9
Hairy grama	7.2 ± 2.8	6.7 ± 3.9	3.8 ± 3.4
Little bluestem	5.2 ± 2.2	12.1 ± 7.0	5.8 ± 3.2
Hall's panicum	4.5	4.6	4.6
Dropseeds	3.4	3.7	5.5
Sand lovegrass	1.4	3.2	0.9
Paspalum	0.6	1.6	1.9
False buffalograss	0.6	0.7	1.1
Trace species	0.3 (2)[c]	0.3 (4)	0.3 (1)
Total Grasses	57.8	58.2	42.2
Shrubs			
Shinnery oak	28.9 ± 7.6	29.1 ± 7.5	43.8 ± 7.5
Yucca	0.7	1.3	0.7
Sand sagebrush	0.5	0.3	0.9
Trace species	0.5 (6)	0.2 (8)	0.4 (6)
Total Shrubs	30.6	30.9	45.8
Forbs	11.4	11.0	12.0

[a]Number of transect clusters in each subtype.

[b]Mean and standard deviation.

[c]Species making up less than 0.5% each of the total composition in each subtype, and number in parentheses.

Table 3. Percent total ground cover in the Shinnery Oak-tallgrass and Mesquite-shortgrass habitat types/subtypes.

Types/Subtypes	Plant	Litter	Bare
Shinnery Oak-tallgrass			
Subtype 1 (30)[a]	18.8 ± 5.4[b]	42.9 ± 6.4	38.3 ± 4.4
Subtype 2 (60)	11.9 ± 4.7	33.0 ± 7.5	55.7 ± 11.4
Subtype 3 (32)	9.2 ± 2.1	31.7 ± 6.4	59.1 ± 7.2
Mesquite-shortgrass (30)	26.3 ± 2.1	19.4 ± 11.1	54.1 ± 9.2

[a]Number of transect clusters in each type/subtype.

[b]Mean and standard deviation.

small amounts. Forbs average 4.8 percent of the composition (Table 4). The amount of mesquite in this habitat type is quite variable, some areas being devoid of mesquite, and others having stands of moderate density.

Similarities between habitat types are limited to three-awn and dropseed grasses and total forbs. There is slightly less of three-awns, dropseeds, and total forbs in Mesquite-shortgrass than in the subtypes of Shinnery Oak-tallgrass (Tables 2, 4). There is more total plant cover and less ground litter in Mesquite-shortgrass than in Shinnery Oak-tallgrass (Table 3).

Table 4. Percent basal composition of vegetation in the Mesquite-shortgrass habitat type.

Species	Percent Composition
Grasses	
Blue grama	63.5 ± 16.4[a]
Buffalo grass	15.9 ± 20.2
Three-awns	6.0 ± 8.0
Dropseeds	2.2 ± 4.0
Sideoats grama	0.6 ± 1.4
Trace species	0.3 (4)[b]
Total Grasses	89.1
Shrubs	
Broom snakeweed	5.5 ± 7.6
Trace species	0.6 (4)
Total Shrubs	6.1
Forbs	
Croton	1.4 ± 1.9
Unclassified forbs	3.1 ± 4.0
Trace species	T[b] (1)
Total Forbs	4.8

[a]Mean and standard deviation.

[b]Species making up less than 0.5% each of the total composition in each subtype, and number in parentheses.

METHODS

Trapping

Trapping was begun on 30 March 1977, with the objective of capturing at least 10 female lesser prairie chickens to be equipped with radio transmitters. A total of 13 males and 11 females were captured during the 28 days ~~(117 man-days)~~ of trapping. One male died as a direct result of trapping, resulting in a mortality rate of 4.2 percent. Three females were captured on 12 April, 2 each on 13 and 15 April, and 1 each day from 17 through 20 April, indicating mid-April as the best period for capturing females in this area. Davis et al. (1977), working in the same area in 1976, suggest that late March to mid-April is the best period for capturing females.

Several trapping procedures were used on 5 individual sites, all on or adjacent to booming grounds. Use of a 10 m x 20 m 3-cannon net was the most effective method. Eight of 11 females and 1 male were caught in this net. A 10 m x 20 m 3-rocket net was utilized during the last few days of trapping, and 1 female was trapped with this net. Cannon and rocket nets required little preparation during the early, dark hours before trapping began each morning. Also, females appeared to be less alarmed by these nets than by mist nets which were used. The blind was placed about 10 m from either edge of the net, in line with the 3 cannons or rockets.

Most of the effort by individuals during the trapping period was directed toward the use of vertical mist nets (Campbell 1972). Twelve of 13 males but only 2 females were captured using these nets. Davis

et al. (1977) reported considerable success with mist nets in the same area during the dry spring of 1976. They placed the nets at livestock water troughs and drove females from the trough into the net. However, spring 1977 was not as dry and the females did not utilize the water troughs. On the booming grounds, females were very wary of mist nets. Males often ignored the nets and were captured with comparative ease.

Telemetry

The 11 females captured in 1977 were equipped with radio transmitters so their movements and nesting and brooding habitat could be studied. Ten of the transmitters were battery-powered and charged by solar panels located on the top of the transmitter. The solar-powered transmitter package, consisting of transmitter, harness and antenna, weighed approximately 18 g, and was built by Wildlife Materials, Inc., Carbondale, Illinois. The harness used with the solar-powered transmitters was a type of back-pack harness. Nylon cord approximately 0.3 cm in diameter was looped under 1 wing and through holes in the front and rear of the transmitter, and then tied with a square-knot under the other wing. The amount of slack in the cord was standardized by placing 2 fingers between the transmitter and the back of the bird, drawing up any slack and tying the knot. The knot and both ends of the cord were slightly melted with a match to prevent the knot from slipping.

The other transmitter was lithium battery-powered, and was built by Sidney L. Markusen of Esko, Minnesota. The transmitter package,

consisting of the battery, harness and antenna, weighed approximately 20 g, and was similar to the 1 described by Brander (1968).

The transmitters utilized frequencies of 150-155 mHz. Females were relocated periodically by use of a portable receiver and a hand-held hagi antenna, purchased from Wildlife Materials, Inc. The usual procedure was to begin by returning to the last known location of a particular bird and scanning in all directions to make radio contact with the bird. Once the general direction of the bird from the observer was determined, closer tracking identified the exact location of the bird. Two attempts were made in late spring and mid-summer to locate missing females by use of a Cessna 172 aircraft with a yagi antenna attached to a wing strut. Flights were made at an altitude of approximately 1,000 m above ground level until contact was made, and then at lower altitudes until the bird could be identified as being in an area of less than about 1 km in diameter. An average ground-speed of 120 kph usually was maintained during the search. During these flights, signals from functioning transmitters were received from distances of over 10 km.

Vegetation

Individual use-sites (eg., foraging sites) were found by radio-location and by searches of the study area. Data from each site were recorded from a cluster of eight 3 m, line-point transects with data points at 0.3 m intervals and radiating from the center of the site. Data from nest sites were taken from similar transect clusters, except that these transects extended 9 m and provided 240 data points

per cluster. Similar data were taken from the 2 types of transects. Bare ground, litter, or plant species present were recorded for each point; these data were used to compute ground cover. Where the point was on bare ground or litter, an additional tally on plants was made of the nearest plant ahead of the point. These data were pooled with those directly on points to compute percent composition. Height was measured to the nearest centimeter for the plant nearest each third data point on each transect, yielding 25 height measurements for each 3 m transect cluster. Height of vegetation covering nests was recorded separately, and height of nearest plant was measured at every third point on the 9 m transects, yielding 80 measurements per transect cluster around each nest site.

Clusters of paced transects were used to gather data for description of vegetation subtypes and to gather additional data around nest sites. Each of these clusters consisted of 4 transects radiating on principal compass bearings from a center point. The observer walked 100 steps (approximately 90 m) on each transect with the toe of the right boot being the data point. This gave 50 data points per transect and 200 points per cluster. Notes on bare ground, litter, and plants were made for each point in manner described for the smaller transect clusters.

Height and livestock utilization of 24 randomly selected plants each of sand bluestem, little bluestem, and dropseeds were recorded for the area within 9 m of each nest site. The height of each plant in the sample was measured in centimeters, and percent utilization was estimated by ocular comparison with other plants of the same species.

At some sites, fewer than 24 plants of each species were present within 9 m of the nest site. In this case, the sample was considered complete when it contained all such plants present in this area.

NEST SITE SELECTION

This section summarizes data collected from 18 nests. Six nests were found in 1976, 3 by radio-location and 3 incidental to other work. Twelve were found in 1977, all by radio-location of females.

Influence of Subtypes

The distribution of nests among vegetation types and subtypes was significantly different ($P < 0.01$) from that expected on the basis of the proportion of the study area occupied by each type/subtype (Table 5). Sixteen of 18 nests were found in Subtypes 1 and 2, the grassier subtypes of Shinnery Oak-tallgrass. The number of nests (6) found in Subtype 1 was 3 times greater than expected. Vegetation in this subtype includes the highest proportion of grasses, especially sand bluestem, of any part of the study area (Table 2).

Nest-finding techniques were not biased for nest locations in Subtype 1. Female prairie chickens were captured from 6 booming grounds scattered over the study area. All of these booming grounds were immediately surrounded by vegetation types/subtypes other than Subtype 1, and movements from capture to nest sites were over 2 km in some cases, crossing all vegetation types/subtypes. Three nests were found (all in Subtype 1) while walking transects across all vegetation types/subtypes.

Influence of Vegetation in Subtypes

Composition of vegetation around nests in Subtype 1 indicates a

Table 5. Chi square test of number of nests in relation to relative extent of habitat types and subtypes.

Habitat Types	Percent of Study Area	Nests Observed	Nests Expected (% area x 18)	$\frac{(O-E)^2}{E}$
Shinnery Oak-Tallgrass				
Subtype 1	12	6	2	8.00
Subtype 2	42	10	8	0.50
Subtype 3	32	2	6	2.67
Mesquite-shortgrass	14	0	2	2.00
	100	18	18	13.17[a]

[a]Chi square (alpha = 0.01, d.f. = 3) = 11.34.

selection for grassier areas within the subtype (Table 6). There was progressively more sand bluestem and total grasses in the composition within 90, 9, and 3 m of the nests. Also, little bluestem was more abundant in the composition within 3 m of the nests than within either 9 or 90 m. These differences were accompanied by corresponding decreases in the proportions of shinnery oak, total shrubs, and total forbs in the composition within 90, 9, and 3 m of the nests; also, grasses were much more abundant than shrubs near the nest. Selection for grassier sites in Subtype 1 is shown, also, by more grass near nests (within 3 m = 66.9%) than in average composition in the subtype (57.8%) (Table 2).

In Subtype 2, more shrub cover was present near nests than in Subtype 1. Also, there apparently was progressively more shrub and less grass cover nearer nests (Table 7). This suggestion is tentative, due to slight overall differences at various distances from the nest and large variation in the data from within 3 m of the nest. Sample size for Subtype 3 was too small to permit any firm interpretations from the data, but indications of nest site selection are similar to those from Subtype 2 (Tables 7, 8). In Subtypes 2 and 3, selection for brushier sites is shown, also, by presence of more brush and less grass near nests than in the average composition in the subtypes (Table 2).

Ground Cover

There was progressively more litter and less bare ground within 90, 9 and 3 m of nests in each subtype (Table 9). Increased litter could result from more dense vegetation around nests, or from placement

Table 6. Percent basal composition of vegetation within 3, 9, and 90 m of 6 lesser prairie chicken nests in Shinnery Oak-tallgrass, Subtype 1.

Species	3 m	9 m	90 m
Grasses			
Sand bluestem	38.4 ± 11.7[a]	30.4 ± 9.8	25.9 ± 3.4
Little bluestem	7.3 ± 8.6	7.1 ± 4.3	4.8 ± 1.1
Three-awns	7.7 ± 3.9	8.3 ± 4.4	7.4 ± 2.0
Dropseeds	4.6 ± 3.7	6.5 ± 3.4	6.9 ± 2.8
Hairy grama	6.1 ± 5.1	4.5 ± 3.1	5.8 ± 1.2
Hall's panicum	1.5 ± 1.1	3.7 ± 2.5	4.2 ± 2.1
Total Grasses	66.9 ± 7.3	62.7 ± 6.9	56.7 ± 2.8
Shrubs			
Shinnery oak	30.0 ± 7.4	33.1 ± 7.1	32.5 ± 5.4
Yucca	0.4 ± 0.9	0.8 ± 0.3	0.8 ± 0.6
Prickly pear	0.2 ± 0.4	0.4 ± 0.6	0.3 ± 0.4
Sand sagebrush	0.4 ± 0.6	0.8 ± 0.7	1.3 ± 1.5
Total Shrubs	31.0 ± 8.1	34.9 ± 7.9	37.8 ± 5.4
Forbs	2.1 ± 1.5	2.6 ± 2.7	5.6 ± 5.3

[a]Mean and standard deviation.

Table 7. Percent basal composition of vegetation within 3, 9, and 90 m of 10 lesser prairie chicken nests in Shinnery Oak-tallgrass, Subtype 2.

Species	3 m	9 m	90 m
Grasses			
Sand bluestem	7.9 ± 8.4[a]	9.2 ± 4.9	8.9 ± 3.8
Little bluestem	4.2 ± 4.2	4.5 ± 3.0	6.3 ± 3.2
Three-awns	14.6 ± 6.7	17.6 ± 7.9	15.6 ± 6.0
Dropseeds	6.8 ± 4.6	5.1 ± 2.1	7.5 ± 4.2
Hairy grama	4.8 ± 5.0	4.7 ± 4.0	4.4 ± 3.5
Hall's panicum	4.9 ± 7.6	5.2 ± 5.2	4.1 ± 2.6
Total Grasses	46.9 ± 13.1	51.5 ± 8.4	52.1 ± 4.4
Shrubs			
Shinnery oak	46.8 ± 10.7	42.5 ± 6.9	39.4 ± 6.4
Yucca	1.5 ± 3.4	1.2 ± 1.3	1.4 ± 1.5
Prickly pear	0.1 ± 0.4	0.1 ± 0.2	0.1 ± 0.2
Sand sagebrush	0.9 ± 2.0	0.7 ± 0.9	0.5 ± 0.5
Total Shrubs	49.3 ± 13.8	44.5 ± 7.3	41.9 ± 6.0
Forbs	3.9 ± 3.9	4.2 ± 4.1	6.0 ± 3.8

[a]Mean and standard deviation.

Table 8. Percent basal composition of vegetation within 3, 9, and 90 m of 2 lesser priaire chicken nests in Shinnery Oak-tallgrass, Subtype 3.

Species	3 m			9 m			90 m		
Grasses									
Sand bluestem	0.0	±	0.0	0.0	±	0.0	1.5	±	1.5[a]
Little bluestem	0.7	±	0.7	0.9	±	0.8	2.5	±	0.5
Three-awns	20.7	±	18.2	22.5	±	17.5	17.8	±	8.3
Dropseeds	10.7	±	10.6	14.6	±	14.2	10.0	±	5.0
Hairy grama	2.5	±	2.5	2.7	±	2.7	2.0	±	2.0
Hall's panicum	0.0	±	0.0	0.0	±	0.0	0.8	±	0.7
Total Grasses	37.0	±	9.4	42.5	±	5.8	36.3	±	2.3
Shrubs									
Shinnery oak	55.7	±	4.3	49.8	±	0.7	49.5	±	6.0
Yucca	3.2	±	3.2	1.9	±	1.4	3.0	±	0.5
Sand sagebrush	1.3	±	1.3	0.9	±	0.8	2.0	±	2.0
Total Shrubs	60.1	±	8.8	53.4	±	2.4	54.7	±	3.2
Forbs	3.0	±	0.6	4.1	±	3.4	9.0	±	5.5

[a]Mean and standard deviation.

Table 9. Percent ground cover within 3, 9, and 90 m of 18 lesser prairie chicken nests in the Shinnery Oak-tallgrass habitat type.

	Plant			Litter			Bare		
Subtypes	3 m	9 m	90 m	3 m	9 m	90 m	3 m	9 m	90 m
1 (6)[a]	18.6	15.3	15.8	56.3	52.4	42.6	25.2	32.4	41.6
2 (10)	11.4	10.6	13.2	45.0	40.5	29.2	43.6	48.9	57.6
3 (2)	17.6	14.8	20.3	46.3	37.3	16.1	36.2	37.2	63.0
Combined (18)	14.4	13.3	15.4	48.9	43.0	32.3	36.7	43.7	52.9

[a]Number of nests.

of nests in litter-holding areas.

Topography in Nesting Areas

Nest site selection appears to be influenced by topography. All nests were located in depressions within low sandhills, although nesting females often fed in higher sandhills, nearby. These small depressions usually were more grassy than the ridges immediately around them. There usually were hillocks within 15 m of the nest, 1 or 2 m higher than the bottom of the depression. These hillocks were located to the south, southwest or west at 16 of the 18 nest sites. This tendency may have resulted from females avoiding wind while selecting nest sites. Nests were not necessarily placed at the lowest areas in the depression; 12 were located on the slopes.

Nest Placement

The principal cover over 13 of the 18 nests was provided by grasses (Table 10). Where sand bluestem was the most abundant grass (Subtype 1), it provided overhead cover for half (3 of 6) of the nests. In Subtype 2, three-awns and little bluestem are the most abundant grasses, and 4 of 10 nests were placed in clumps of these grasses. However, some selection for sand bluestem as overhead cover for nests also is apparent in Subtype 2 (Table 10), despite abundance of sand bluestem in this subtype being less than one-third of that in Subtype 1 (Table 2). Sand bluestem is grazed heavily in Subtype 2, and this may have caused females to select ungrazed clumps of other grasses as nest cover. Nest cover in Subtype 3 was

Table 10. Numbers of nests placed in cover of various plant species in the Shinnery Oak-tallgrass habitat type.

Species	Subtypes 1	2	3	Combined
Grasses				
Sand bluestem	3[a]	2	0	5
Little bluestem	2	2	0	4
Silver bluestem	0	1	0	1
Total Under Bluestems	5	5	0	10
Three-awns	0	2	1	3
Total Under Grasses	5	7	1	13
Shrubs				
Sand sagebrush	0	2	1	3
Yucca	1	0	0	1
Total Under Shrubs	1	2	1	4
Forbs				
Broom groundsel	0	1	0	1
Total Under Forbs	0	1	0	1

[a]Number of nests.

provided by three-awn grasses (1 of 2) and sand sagebrush (1 of 2) (Table 10). Grasses in this subtype are mainly three-awns; all others are grazed very heavily by livestock. Therefore, shrubs might provide better cover above nests than the heavily grazed grass clumps.

Fourteen of the 18 nests were placed in or beside lightly grazed or ungrazed clumps of vegetation. Only 4 nests were placed in or beside heavily grazed clumps. In Subtypes 2 and 3, where grazing is the heaviest in Shinnery Oak-tallgrass, grasses still provide overhead cover for two-thirds (8 of 12) of the nests.

Reasons for selecting areas of greater abundance of tallgrass or shrub cover (especially sand bluestem and shinnery oak) probably are related to growth form of plants, as exemplified by height, width, shape, etc. Other grouse species are known to respond to growth form of vegetation in selecting nest habitat (Christenson 1971, Hillman and Jackson 1973, Wallestad 1975).

Females selected taller plants for nest cover. The average height of plants within 9 m of all nests (28.5 cm) was significantly less ($P < 0.10$)[2] than the average height of cover directly above all nests (60.6 cm). A similar difference occurred also, between nests in different subtypes (Table 11). The cover directly above all nests was slightly greater than the average height of sand bluestem (50.4 cm) and of little bluestem (55.5 cm) within 9 m of all nests.

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[2] Student's *t* test of significance used throughout remainder of report.

Table 11. Center height of cover above and mean height of cover within 9 m of 18 lesser prairie chicken nests in the Shinnery Oak-tallgrass habitat type.

Subtype	Center Height (cm)	Mean Height (cm)
1 (6)[a]	73.7	33.8
2 (10)	54.9	25.5
3 (2)	50.0	27.9
All Nests (18)	60.6	28.5

[a]Number of nests.

Summary

Females were rather mobile while selecting nesting sites, moving as much as 2 km across all vegetation types and subtypes. The greatest concentration of nests occurred in Subtype 1 of Shinnery Oak-tallgrass, where sand bluestem was abundant and grazing absent or minimal. In this subtype, the birds nested within small areas where total grass cover was even greater than average for the subtype. Within these small areas, nests (5 of 6) were placed within or against clumps of bluestem, especially sand bluestem, which were taller than other plants nearby.

In Subtypes 2 and 3, where sand bluestem was relatively scarce and grazing heavier, the birds nested in small areas of heavy shrub cover, evidently substituting shrubs for grasses. Within these small, shrubby areas, most nests (8 of 12) still were placed in or against taller grass clumps, but greater use was made of other vegetation (4 of 12) than in Subtype 1.

NESTING SUCCESS

Influence of Subtype

Seventeen of the 18 nest sites were evaluated for vegetational influence on nesting success; success was not known for 1 nest in Subtype 1 of the Shinnery Oak-tallgrass type. Percent nesting success in Subtype 1 was greater than that in either Subtype 2 or Subtype 3 (Table 12). Subtype 1 differs from the other 2 subtypes in having more grass cover, especially sand bluestem (Table 2), and more total cover (Table 3). It is presumed that this cover provided by sand bluestem near nests provides superior concealment, as well as a general screening of the nest and hen movements near the nest. Nest predators, such as coyotes (*Canis latrans*), may avoid areas of dense sand bluestem in favor of areas where vegetation is sparse and prey is more conspicuous. Only 1 of 5 nests located in Subtype 1 was lost to predation (Table 12). The relationship between vegetational cover and nesting success is examined further in the following sections by comparing vegetation near successful nests with that near unsuccessful nests in each of the 3 subtypes.

Influence of Vegetation in Subtypes

In Subtypes 1 and 2, successful nests apparently had a higher percent of grasses in the composition within 3 and 9 m than did unsuccessful nests; in Subtype 2, this difference apparently extended to 90 m, also (Tables 13, 14). The species contributing most of this difference were three-awns (in both subtypes), hairy grama and little

Table 12. Nesting success of 17 lesser prairie chickens as related to the Shinnery Oak-tallgrass subtype in which nests were located.

Subtype	Successful No.	Successful %	Unsuccessful (Fate of nest)
1	4	80	1 (Predation)
2	3	30	7 (5 predation, 2 abandoned)
3	1	50	1 (Abandoned)
Combined	8	47	9 (6 predation, 3 abandoned

Table 13. Percent basal composition of vegetation within 3, 9, and 90 m of 4 successful and 1 unsuccessful nest in the Shinnery Oak-tallgrass, Subtype 1.

Species	3 m		9 m		90 m	
	Successful	Unsuccessful	Successful	Unsuccessful	Successful	Unsuccessful
Grasses						
Sand bluestem	36.0 ± 13.1[a]	37.5	26.9 ± 6.5	25.8	26.1 ± 4.0	24.0
Little bluestem	8.8 ± 10.1	2.5	7.0 ± 5.2	8.3	4.1 ± 0.8	6.0
Three-awns	8.8 ± 4.4	5.0	10.1 ± 4.4	4.6	5.0 ± 3.1	8.0
Dropseeds	2.5 ± 2.5	7.5	5.2 ± 3.5	8.3	6.5 ± 2.8	10.0
Hairy grama	8.1 ± 4.9	3.8	6.0 ± 2.5	2.9	6.3 ± 1.0	4.0
Hall's panicum	1.6 ± 1.0	0.0	4.6 ± 2.7	1.3	4.0 ± 1.8	3.5
Total Grasses	67.2 ± 6.4	57.5	62.4 ± 4.1	52.9	56.3 ± 3.3	56.5
Shrubs						
Shinnery oak	29.4 ± 6.5	40.0	33.5 ± 6.3	40.8	37.6 ± 4.4	33.5
Yucca	0.6 ± 1.0	0.0	1.0 ± 1.0	0.8	0.6 ± 0.5	0.5
Prickly pear	0.3 ± 0.5	0.0	0.2 ± 0.2	0.0	0.5 ± 0.4	0.0
Sand sagebrush	0.0 ± 0.6	0.0	0.6 ± 0.4	2.1	0.8 ± 0.3	4.5
Total Shrubs	30.9 ± 7.7	40.0	35.4 ± 6.5	43.7	39.9 ± 4.3	38.5
Forbs	1.9 ± 1.9	2.5	2.4 ± 3.3	3.3	3.9 ± 5.1	5.0

[a]Mean and standard deviation.

Table 14. Percent basal composition of vegetation within 3, 9, and 90 m of 3 successful and 7 unsuccessful nests in the Shinnery Oak-tallgrass, Subtype 2.

Species	3 m		9 m		90 m	
	Successful	Unsuccessful	Successful	Unsuccessful	Successful	Unsuccessful
Grasses						
Sand bluestem	7.1 ± 10.0[a]	8.2 ± 7.5	9.3 ± 5.9	9.2 ± 6.0	8.6 ± 4.9	9.0 ± 3.2
Little bluestem	2.1 ± 2.6	5.2 ± 4.6	2.2 ± 1.9	5.5 ± 3.3	4.4 ± 2.9	7.2 ± 2.9
Three-awns	20.0 ± 2.7	12.3 ± 6.5	24.1 ± 5.1	14.8 ± 7.2	19.6 ± 5.8	14.6 ± 5.3
Dropseeds	8.8 ± 7.0	5.9 ± 2.5	6.0 ± 2.6	5.1 ± 1.8	11.8 ± 2.8	5.6 ± 3.3
Hairy grama	4.6 ± 4.1	4.8 ± 5.3	5.1 ± 4.0	4.5 ± 4.1	3.8 ± 5.1	4.6 ± 2.6
Hall's panicum	5.4 ± 6.8	4.7 ± 7.9	6.4 ± 4.9	4.7 ± 5.1	3.0 ± 1.4	4.5 ± 2.8
Total Grasses	50.9 ± 6.8	45.2 ± 14.7	57.1 ± 5.9	48.7 ± 8.1	53.5 ± 4.0	51.5 ± 4.4
Shrubs						
Shinnery Oak	44.6 ± 7.9	47.7 ± 11.5	35.8 ± 7.6	45.4 ± 4.1	34.5 ± 2.7	41.5 ± 6.3
Yucca	1.2 ± 1.7	1.6 ± 4.0	1.3 ± 0.4	1.1 ± 1.6	2.4 ± 2.3	1.2 ± 0.9
Prickly pear	0.0 ± 0.0	0.2 ± 0.4	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.2
Sand sagebrush	0.0 ± 0.0	1.3 ± 2.2	0.6 ± 0.8	0.8 ± 0.9	0.5 ± 0.7	0.4 ± 0.3
Total Shrubs	45.8 ± 9.2	50.7 ± 15.1	37.9 ± 7.7	47.4 ± 4.9	37.9 ± 1.4	43.6 ± 6.4
Forbs	3.3 ± 2.5	4.1 ± 4.3	5.0 ± 3.6	3.9 ± 4.2	8.5 ± 3.9	4.9 ± 3.2

[a]Mean and standard deviation.

bluestem (Subtype 1), and dropseeds (Subtype 2). These data provide further evidence that heavy grass cover, as found in Subtype 1 and in parts of Subtype 2, provides security for nests, thereby enhancing their probability of success. Nests placed in grass cover are less conspicuous than those placed in shrubs or forbs because grasses usually have greater stem density. Nest concealment is provided by dried vegetation which grew in previous years, because new growth has just begun at the time of nesting. Grass clumps usually retain more foliage from previous years than do shrubs or forbs, providing more litter and standing dead stems for nest concealment. However, there apparently was a selection for nest sites in brushier areas in Subtype 2 (Table 7). Females may return to their natal area to nest. Svedarsky (1977:5) noted that female greater prairie chickens (T. cupido) return to nest in areas of previously successful nests. This might explain why some lesser prairie chickens nest in areas of lesser grass cover (Subtype 2), although their nests would have a greater probability of success in the more grassy areas (Subtype 1).

In Subtype 3, where grasses are very sparse, the single successful nest had less grass and more shrubs in the composition within 3 and 9 m than did the 1 unsuccessful nest (Table 15). These data suggest that in this shrubby subtype, dense shrubs may substitute to some degree for grasses in providing security for nests. The principal shrub near nests was shinnery oak, but yucca and sand sagebrush also were more prominent near the successful nest than in the other subtypes (Tables 13, 14, 15).

Total plant cover around nests provides further insight into the

Table 15. Percent basal composition of vegetation within 3, 9, and 90 m of 1 successful and 1 unsuccessful nest in the Shinnery Oak-tallgrass, Subtype 3.

Species	3 m		9 m		90 m	
	Successful	Unsuccessful	Successful	Unsuccessful	Successful	Unsuccessful
Grasses						
Sand bluestem	3.8	0.0	0.0	0.0	3.0	0.0
Little bluestem	0.0	1.3	0.0	1.7	2.0	3.0
Three-awns	2.5	38.8	5.0	40.0	9.5	26.0
Dropseeds	21.2	0.0	28.8	0.4	15.0	5.0
Hairy grama	0.0	5.0	0.0	5.4	0.0	4.0
Hall's panicum	0.0	0.0	0.0	0.0	1.5	0.0
Total Grasses	27.5	46.3	36.7	48.3	34.0	38.5
Shrubs						
Shinnery oak	60.0	51.3	49.2	50.5	43.5	55.5
Yucca	6.3	0.0	3.3	0.4	3.5	2.5
Sand sagebrush	2.5	0.0	1.7	0.0	4.0	0.0
Total Shrubs	68.8	51.3	55.8	50.9	51.5	58.0
Forbs	3.7	2.4	7.5	0.8	14.5	3.5

question of the influence of vegetation on nesting success. In Subtype 1, total plant cover within 9 m of nests apparently did not affect nesting success because the amount of this cover was quite similar for successful and unsuccessful nests (Table 16). In Subtype 2, where less plant cover was present (Table 16), slightly more cover apparently was present around successful nests than around unsuccessful nests, suggesting that vegetation in some areas of this subtype did not provide sufficient security for nests. In Subtype 3, total plant cover within 9 m of the 1 successful nest was twice as great as within 9 m of the unsuccessful nest (Table 16), suggesting a strong effect of total plant cover on nesting success. However, sample size from Subtype 3 was much too small to support a strong conclusion in this regard.

Nest Placement

The growth form of sand bluestem appears to favor nesting success. Four of the 8 successful nests were located in or between sand bluestem clumps and 1 in a clump of silver bluestem, which has a similar growth form (Table 17). Sand bluestem clumps often are as much as 3 m in diameter. The clump is composed of much litter and standing growth which is very loose in nature, so that nests can be placed inside with little effort. Nests placed in or between sand bluestem clumps were concealed from above and on all sides and were difficult to see, even when the observer was near the nest. Only 2 of the 9 unsuccessful nests were placed in association with sand bluestem, and they were in heavily grazed clumps, where concealment had been reduced considerably (Table 17).

Table 16. Average percent total plant cover within 9 m of lesser prairie chicken nests in Shinnery Oak-tallgrass as related to success.

	Average Percent Plant Cover	Number of Nests
All successful nests	14.22	8
All unsuccessful nests	10.32	9
Subtype 1		
All successful nests	15.21	4
All unsuccessful nests	15.81	1
Subtype 2		
All successful nests	10.85	3
All unsuccessful nests	9.71	7
Subtype 3		
All successful nests	20.42	1
All unsuccessful nests	9.18	1
All nests combined	13.01	18

Table 17. Success, age of vegetation and placement of 18 lesser prairie chicken nests.

Nest Number	Success	Age of Vegetation[a]	Placement
1976			
1	Hatched	Old (2)[b]	In lightly grazed clump of three-awn grass.
1A	Hatched	Old (1)	Beside lightly grazed yucca and sand bluestem clumps.
4	Hatched	Old (1)	Beside ungrazed little bluestem clump.
5	Hatched	Old (1)	In ungrazed sand bluestem clump.
7	Abandoned	Old (2)	Beside lightly grazed little bluestem clump.
8	Unknown	Old (1)	In between lightly grazed little and sand bluestem clumps.
1977			
9	Predation	Old (2)	Beside lightly grazed three-awn clump.
10	Predation	Old (2)	Beside lightly grazed little bluestem clump.
11	Predation	Current (2)	In ungrazed clump of sand sagebrush.
12	Predation	Current (2)	Beside lightly grazed broom groundsel clump.
13	Abandoned	Current (2)	Beside ungrazed clump of sand sagebrush.
14	Predation	Old (2)	In heavily grazed clump of sand bluestem.
15	Hatched	Old (2)	In heavily grazed clump of sand bluestem
16	Hatched	Mostly current some old (3)	In between ungrazed clump of sand sagebrush and yucca.

Table 17 (Cont'd)

Nest Number	Success	Age of Vegetation[a]	Placement
1977			
17	Predation	Old (1)	In heavily grazed clump of sand bluestem.
18	Hatched	Mostly old, some current (2)	In between lightly grazed clumps of silver bluestem, dropseeds and shinnery oak.
19	Hatched	Old (1)	In ungrazed clump of sand bluestem.
20	Abandoned	Mostly current, some old (3)	Beside heavily grazed clumps of three-awns and shinnery oak.

[a]Old growth refers to vegetation that is growth still standing from previous years. Current growth refers to vegetation that grew during the year of the nest.

[b]Shinnery Oak-tallgrass subtype where nest was located.

Discussion

Six of the 9 unsuccessful nests were lost to predation. If more grass cover or other dense vegetation had been present, location of nests by predators might have been less frequent. The remaining 3 unsuccessful nests were lost to abandonment. Two of these were abandoned before egg-laying was completed. Close proximity of observers to the nests during egg-laying probably caused the 2 hens to abandon their nests. Presence of more cover from grass or more dense vegetation might have made the birds less prone to desert. The remaining nest was abandoned after 4 weeks of incubation. Apparently, the embryos died before the nest was abandoned. The nest was not protected from the sun, and the embryos possibly were killed by overheating.

BROOD HABITAT

In 1977, broods and/or their sign were found in the Shinnery Oak-tallgrass type, in low sandhills where slopes were not particularly steep or high. No evidence of brood-use was seen in the Mesquite-shortgrass type. Vegetation was sampled at 54 brood-foraging sites, including 44 found by radio-location and 10 found while doing other work. Day-resting and night-roosting sites located in this study were too few to report on at this time.

Subtypes

During June and July, broods were more abundant in Subtypes 2 and 3 of Shinnery Oak-tallgrass, where grasses and total ground cover were relatively sparse (Tables 2, 3), than in Subtype 1 or Mesquite-shortgrass (Table 18). Davis et al. (1977), working in the same area in 1976, also reported heaviest brood-use in habitat Subtypes 2 and 3.

Two radio-equipped females and their broods were followed for periods of approximately 3 weeks (hen no. 9) and approximately 6 weeks (hen no. 6). The brood of hen number 9 remained in an area of Subtype 2, while the brood of hen number 6 remained in Subtype 3 throughout the tracking periods. Both females had nested in the subtype where they reared their broods.

Ground Cover

The amount of vegetation at brood-foraging sites appears similar to that within 3 m of all nest sites. There was significantly less

Table 18. Number of broods or brood sign observed per km walked on transects through all habitat types/subtypes.

	Shinnery Oak-tallgrass			Mesquite-shortgrass
	Subtype 1	Subtype 2	Subtype 3	
Distance walked (km)	19.44	73.12	59.53	26.03
Broods/brood sign observed	1	13	7	0
Broods/brood sign per km	0.05	0.18	0.18	0.00

($P < 0.02$) litter at brood-foraging sites than within 3 m of nests. Conversely, there was more bare ground around brood-foraging sites than around nests, but the difference was not significant ($P > 0.10$) (Tables 9, 19). Brood-foraging sites also had less litter and more bare ground than within 9 m of nests (Tables 9, 19). However, none of these differences were significant ($P > 0.10$).

Height of Vegetation

The average height of cover at the center of brood-foraging sites (25.3 $\pm$ 14.6 cm) was very similar to that of all vegetation in the circle (3 m radius) (29.0 $\pm$ 5.6 cm). Both these heights were lower than that of cover above nests (60.6 $\pm$ 26.4 cm), although the differences were not significant ($P > 0.10$). Average height of vegetation at brood-foraging sites (29.0 $\pm$ 5.6 cm) was almost identical to that within 9 m of nests (28.5 $\pm$ 6.8 cm). The fact that vegetation was lower in foraging areas and near nests than it was above nests would give the birds visibility of their surroundings, thereby allowing them to detect predators before they approached closely.

Composition of Vegetation

Three-awn grasses and shinnery oak were the most common plants present (Table 20), although standard deviations for all plants were large, indicating little preference for composition of vegetation where broods foraged. Davis et al. (1977) reported, also, that foraging sites in this study area were dominated by three-awns and shinnery oak.

Table 19. Percent ground cover in a circle of 3 m radius at 54 brood-foraging sites.

Plant	14.61 ± 8.45[a]
Litter	22.23 ± 13.78
Bare ground	63.10 ± 12.72

[a]Mean and standard deviation.

Table 20. Percent basal composition of vegetation in a circle of 3 m radius at 54 brood-foraging sites.

Species	Percent
Grasses	
Sand bluestem	3.3 ± 8.1[a]
Little bluestem	3.2 ± 7.8
Three-awns	16.8 ± 9.5
Dropseeds	4.6 ± 4.9
Hairy grama	1.0 ± 1.7
Hall's panicum	5.8 ± 5.9
False buffalograss	1.3 ± 3.6
Total Grasses	38.5 ± 16.4
Shrubs	
Shinnery oak	42.5 ± 15.8
Yucca	2.4 ± 3.0
Sand sagebrush	2.2 ± 3.0
Rabbitbrush	T[b]
Total Shrubs	47.0 ± 16.5
Forbs	
Annual eriogonum	3.7 ± 3.6
Euphorbia	1.9 ± 3.8
Western ragweed	1.6 ± 5.6
Croton	1.3 ± 1.9
Unclassified forbs	1.3 ± 3.2
Trace forbs	4.1 (21)[c]
Total Forbs	13.7 ± 8.7

[a]Mean and standard deviation.

[b]Species composing less than 1.0% of total composition.

[c]Sum of means and number of trace species in parentheses.

Foraging sites from broods of 2 females carrying radio-transmitters were separated (Table 21). The brood of hen number 6 foraged primarily in Subtype 3, while the brood of hen number 9 foraged in habitat Subtype 2. The amounts of sand bluestem and total grasses appeared greater for brood-foraging sites of hen number 9 (Table 21), and amounts of shinnery oak and total shrubs appeared greater at brood-foraging sites of hen number 6 (Table 21). However, none of these differences were significant ($P > 0.10$). This lack of significant differences between the 2 foraging areas indicates that there may be little preference between Subtypes 2 and 3 for brooding areas. The apparent differences, such as they are, are basically the same as the differences between the 2 habitat subtypes where the broods foraged.

Brood-foraging sites from hen number 6 were separated into morning and evening foraging periods. Evening foraging sites had a greater percentage of three-awn grasses in the composition than did morning foraging sites (Table 22). Again this difference was not significant ($P > 0.10$). Total grasses also made up more of the composition in evening than in morning, but this was only a reflection of the larger percentage of three-awns.

Data from the 10 randomly-located brood-foraging sites were analyzed for basal composition of vegetation. Percentages of sand bluestem and little bluestem in the composition appeared larger, and percentages of three-awns smaller, at these sites than at radio-located sites (Tables 21, 23). None of these differences were significant ($P > 0.10$). One possible reason for these apparent differences is the height difference between bluestem and three-awn

Table 21. Percent basal composition of vegetation in a circle of 3 m radius at 37 radio-located brood-foraging sites of hen number 6 and 7 such sites of hen number 9.

Species	Hen 6	Hen 9
Grasses		
Sand bluestem	T[a]	7.3 ± 5.0[b]
Little bluestem	1.6 ± 2.7	3.0 ± 2.9
Three-awns	17.9 ± 10.0	16.3 ± 6.7
Dropseeds	5.2 ± 4.7	10.2 ± 6.6
Hairy grama	T	2.3 ± 4.4
Hall's panicum	6.6 ± 6.6	4.1 ± 1.6
Palpalum	T	2.7 ± 2.9
False buffalograss	1.8 ± 4.2	2.3 ± 2.9
Total Grasses	34.8 ± 15.2	48.6 ± 16.5
Shrubs		
Shinnery oak	45.6 ± 14.8	30.4 ± 16.5
Yucca	2.2 ± 2.9	2.1 ± 3.4
Sand sagebrush	2.8 ± 3.3	0.0 ± 0.0
Total Shrubs	50.6 ± 15.3	32.5 ± 13.6
Forbs		
Annual eriogonum	4.5 ± 3.7	T
Euphorbia	2.1 ± 4.1	3.0 ± 4.5
Croton	1.6 ± 2.0	T
Western ragweed	1.2 ± 5.3	5.9 ± 8.3
Cryptantha	T	1.1 ± 2.2
Unclassified forbs	T	4.7 ± 4.5
Trace forbs	11.1 (15)[c]	2.4 (5)
Total Forbs	14.3 ± 7.8	17.7 ± 9.7

[a]Species composing less than 1.0% of total composition.

[b]Mean and standard deviation.

[c]Sum of means and number of trace species in parentheses.

Table 22. Percent basal composition of vegetation in a circle of 3 m radius at 20 morning and 17 evening radio-located brood-foraging sites of hen number 6.

Species	Morning	Evening
Grasses		
Sand bluestem	T[a]	T
Little bluestem	1.3 ± 2.0[b]	1.8 ± 3.3
Three-awns	14.8 ± 8.9	21.5 ± 9.9
Dropseeds	5.9 ± 5.0	4.4 ± 4.2
Hall's panicum	6.4 ± 6.6	6.9 ± 6.5
False buffalograss	2.1 ± 5.4	2.2 ± 3.2
Paspalum	T	T
Hairy grama	T	T
Total Grasses	31.5 ± 15.5	38.7 ± 13.9
Shrubs		
Shinnery oak	46.8 ± 15.1	44.2 ± 14.9
Yucca	1.8 ± 2.5	2.4 ± 3.2
Sand sagebrush	2.4 ± 2.8	2.8 ± 3.5
Total Shrubs	51.0 ± 15.2	50.2 ± 15.4
Forbs		
Annual eriogonum	4.8 ± 3.7	4.2 ± 3.7
Euphorbia	3.2 ± 5.2	T
Western ragweed	2.2 ± 7.0	T
Croton	1.7 ± 1.8	1.5 ± 2.2
Chaffweed	T	1.5 ± 2.3
Desmanthus	T	1.3 ± 2.7
Unclassified forbs	2.4 ± 3.8	T
Trace forbs	2.4 (9)[c]	2.0 (7)
Total Forbs	17.2 ± 7.6	11.0 ± 6.7

[a]Species composing less than 1.0% of total composition.

[b]Mean and standard deviation.

[c]Sum of means and number of trace species in parentheses.

Table 23. Percent basal composition of vegetation in a circle of 3 m radius at 10 randomly located brood-foraging sites.

Species	Percent
Grasses	
Sand bluestem	9.0 ± 10.8[a]
Little bluestem	9.3 ± 15.8
Three-awns	13.4 ± 8.2
Dropseeds	6.1 ± 4.3
Hairy grama	2.9 ± 3.2
Hall's panicum	3.9 ± 4.1
Paspalum	1.3 ± 1.0
Lovegrass	T[b]
Total Grasses	45.8 ± 14.1
Shrubs	
Shinnery oak	39.3 ± 16.6
Yucca	3.2 ± 3.2
Sand sagebrush	1.1 ± 1.2
Total Shrubs	43.6 ± 16.4
Forbs	
Annual eriogonum	2.6 ± 2.9
Unclassified forbs	1.0 ± 1.4
Trace forbs	3.6 (10)[c]
Total Forbs	8.8 ± 8.7

[a]Mean and standard deviation.

[b]Species composing less than 1.0% of total composition.

[c]Sum of means and number of trace species in parentheses.

grasses. Broods located by radio-telemetry, especially the brood of hen number 6, were checked almost daily. This frequent harassment made them more wary of an observer's approach. Three-awns in the study area generally are less than 30 cm tall, whereas bluestems often are 50 cm or taller. Shorter grasses might provide the required cover and insect foods, while enabling a female prairie chicken to locate an approaching observer at a considerable distance. Broods not harassed daily might not occupy such open sites.

RECOMMENDATIONS

Preliminary Management Recommendations

(1) Reduction of grazing pressure in the brushier pastures (Subtype 2 and, especially, Subtype 3 of Shinnery Oak-tallgrass) should improve large areas of habitat for use by nesting prairie chickens. Due to the uneven nature of livestock grazing on the range, there are small areas, within large blocks of Subtype 2 and Subtype 3, that approach the good nesting conditions found in Subtype 1. Reduction of grazing pressure should allow recovery of those smaller areas within Subtypes 2 and 3 that then might serve as nesting habitat. Reduced grazing pressure should improve bluestem (especially sand bluestem) areas and might improve nesting success. This reduction would not, at any time soon, cause the major portions of these pastures to become exceedingly grassy and thereby lower their value as brood-rearing habitat. There will continue to be large brushy areas due to local soil and slope characteristics and to heavy grazing at water, natural gathering sites, livestock trails, etc., and these can be expected to provide ample brood-rearing areas. Grazing reductions must be long-term changes, and areas affected would need to be monitored yearly to evaluate vegetational changes.

If grazing pressure in brushy pastures is not reduced quickly, deterioration of grasslands can be expected to proceed at an accelerated speed because a constant level of grazing on a declining supply of forage (mostly grasses) will only cause the quantity of

grasses to decline progressively faster.

(2) Much of Subtype 1 habitat, which is considered prime nesting habitat, exists because there is no livestock water in these areas and, therefore, they receive little or no grazing. The development of new watering facilities in the study area, therefore, should be curtailed. The establishment of a watering device in any formerly ungrazed area would subject that area to grazing, and would lose its value as nesting habitat quickly. The resident population of lesser prairie chickens would suffer severely as a result of such loss.

(3) Use of types and subtypes described herein for lesser prairie chickens is expected to hold true in other areas of similar habitat. Therefore, the recommendations made above, for the study area, have general applicability in other areas of similar habitat. Habitat development in southeastern New Mexico should provide the elements (mostly the subtypes of Shinnery Oak-tallgrass) which chickens in the study area use. These elements must be close enough together for individual birds to use each of them as the need arises during a year. This requires that a unit of each element be small enough that birds from the center of the unit can move easily to the next element needed.

Recommendations for Further Study

Population trends should be identified so effects of management

practices can be evaluated. Nest success and brood mortality may have a greater effect on population changes from year to year than winter mortality. Mortality during the winter months may be less severe for lesser prairie chickens in the study area than for other grouse species in northern states, because excessive snow depths, extreme cold temperatures, and hunting rarely occur in the study area. Counts of population size, after summer brood mortality, from year to year might be of value in determining the effects of any management practices. Booming ground counts of prairie grouse species have been used in the past to evaluate population changes through time. These counts usually are conducted during spring to obtain an index to changes in the reproductive population after winter mortality. If winter mortality varies little from year to year in the study area, counts during late summer and fall might give a better indication of the effects of management practices than would spring counts. Techniques of measuring population changes should be researched and established, and more research into identifying critical periods of survival should be conducted. Then, alternate management practices could be justified.

LITERATURE CITED

Anderson, K. L., and C. E. Owensby. 1969. Common names of a selected list of plants. Kansas St. Univ. Agric. Exp. Stn. Tech. Bull. 117. 62pp.

Bailey, F. M. 1928. Birds of New Mexico. New Mexico Dept. of Game and Fish, Sante Fe. 807pp.

Barkley, T. M. 1968. A manual of the flowering plants of Kansas. Kansas State Univ. Endowment Assoc., Manhattan. 402pp.

Bent, A. C. 1932. Life histories of North American gallinaceous birds. Smithsonian Institution U. S. National Museum Bull. 162. 490pp.

Brander, R. B. 1968. A radio package harness for game birds. J. Wildl. Manage. 32(3):630-632.

Campbell, H. 1972. A population study of lesser prairie chickens in New Mexico. J. Wildl. Manage. 36(3):689-699.

Christenson, C. D. 1971. Habitat preferences of the sharp-tailed grouse. Fed. Aid in Wildl. Restor. Proj. W-67-R-11, North Dakota State Game and Fish Dept., Bismarck. 53pp. Mimeo.

Copelin, F. E. 1963. The lesser prairie chicken in Oklahoma. Okla. Wildl. Conserv. Dept. Tech. Bull. No. 5. 58pp.

Crawford, J. A. 1974. The effects of land use on lesser prairie chicken populations in west Texas. Ph.D. Thesis. Texas Tech. Univ. 63pp.

Davis, C. A., Suminski, H. R., and T. Z. Riley. 1977. Habitat evaluation of lesser prairie chickens in eastern Chaves County, New Mexico. New Mexico State Univ. Agric. Esp. Stn. Prog. Rep. 88pp. Mimeo.

Donaldson, D. D. 1969. Effect on lesser prairie chickens of brush control in western Oklahoma. Ph.D. Thesis. Okla. St. Univ. 73pp.

Frary, L. G. 1957. Evaluation of prairie chicken ranges. New Mexico Dept. of Game and Fish Proj. Completion Rep., Proj. No. W-77-R-3. 81pp.

Gay, C. W., Jr., and D. D. Dwyer. 1970. New Mexico range plants. New Mexico State Univ. Coop. Ext. Serv. Circ. 374. 85pp.

Greenway, J. C. 1958. Extinct and vanishing birds of the world. Am. Comm. for Internat. Wildl. Protection Spec. Bull. 13. 518pp.

Hamerstrom, F. N., Jr., and F. Hamerstrom. 1961. Status and problems of North American grouse. Wilson Bull. 73(3):284-294.

Hillman, C. N., and W. W. Jackson. 1973. Sharp-tailed grouse in South Dakota. South Dakota Dept. of Game, Fish and Parks Tech. Bull. No. 3. 64pp.

Hoffman, D. M. 1959. Habitat requirements of lesser prairie chickens. Colo. Div. of Wildl. Job Completion Rep., Proj. No. W-37-R-13. 31pp. Mimeo.

_____. 1961. Experimental habitat improvement for lesser prairie chickens. Colo. Div. of Wildl. Job. Completion Rep., Proj. No. W-37-R-14. 6pp. Mimeo.

_____. 1963. The lesser prairie chicken in Colorado. J. Wildl. Manage. 24(4):726-732.

Jackson, A. S., and R. DeArment. 1963. The lesser prairie chicken in the Texas Panhandle. J. Wildl. Manage. 27(4):733-737.

Jones, R. E. 1963. Identification and analysis of lesser and greater prairie chicken habitat. J. Wildl. Manage. 27(4):757-778.

Kearney, T. H., and R. H. Peebles. 1964. Arizona flora. Univ. of Calif. Press, Berkeley and Los Angeles. 1085pp.

Ligon, J. S. 1961. New Mexico birds and where to find them. Univ. of New Mexico Press, Albuquerque. 360pp.

Maker, H. J, Link, V. G., Anderson, J. U., and M. V. Hodson. 1971. Soil associations and land classification for irrigation Chaves County. New Mexico State Univ. Agric. Exp. Stn. Res. Rep. 192. 48pp.

Sell, D. L., and K. L. Stromborg. 1976. Nest sites, movements, and habitat use of lesser prairie chickens. P. 47 in R. E. Sosebee and H. A. Wright eds. Noxious brush and weed control research highlights-1976. Texas Tech. Univ., Lubbock.

Sharpe, R. S. 1968. The evolutionary relationships and comparative behavior of prairie chickens. Ph.D. Thesis. Univ. of Nebraska. 230pp.

Svedarsky, W. D. 1977. Reproductive ecology of the greater prairie chicken in northwestern Minnesota. Proc., Prairie Grouse Tech. Council 12:5.

U. S. Department of Commerce. 1975. Monthly summarized station and divisional data. Climatological Data: New Mexico 79(1-12).

_____. 1976. Monthly summarized station and divisional data. Climatological Data: New Mexico 80(1-12).

_____. 1977. Monthly summarized station and divisional data. Climatological Data: New Mexico 81(1-12).

Wallestad, R. 1975. Life history and habitat requirements of sage grouse in central Montana. Game Manage. Div., Montana Dept. of Fish and Game, Helena. 66pp.

Appendix. List of common and Latin names of plants used in this report.[a]

Common Name	Latin Name
Annual eriogonum	*Eriogonum annum*
Blue grama	*Bouteloua gracilis*
Broom groundsel	*Senecio spartioides*
Broom snakeweed	*Gutierrezia sarothrae*
Buffalo grass	*Buchloe dactyloides*
Chaffweed	*Centunculus minimus*
Desmanthus	*Desmanthus* sp.
Dropseeds	*Sporobolus* spp.
Euphorbia	*Euphorbia* spp.
False buffalograss	*Munroa squarrosa*
Ground-cherry	*Physalis lobata*
Hairy grama	*Bouteloua hirsuta*
Hall's panicum	*Panicum hallii*
Little bluestem	*Andropogon scoparius*
Lovegrass	*Eragrostis* spp.
Mesquite	*Prosopis juliflora*
Paspalum	*Paspalum ciliatifolium*
Prickly pear	*Opuntia* spp.
Rabbitbrush	*Chrysothamnus* sp.
Sand bluestem	*Andropogon hallii*
Sand sagebrush	*Artemesia filifolia*
Scribner's panicum	*Panicum scribnerianum*

Appendix. Continued

Common Name	Latin Name
Shinnery oak	*Quercus havardi*
Sideoats grama	*Bouteloua curtipendula*
Silver bluestem	*Andropogon saccharoides*
Skunkbush	*Rhus aromatica*
Three-awns	*Aristida* spp.
Western ragweed	*Ambrosia psilostachya*
Yucca	Yucca sp.

[a] Plant nomenclature follows Kearney and Peebles (1964), Anderson and Owensby (1969), Gay and Dwyer (1970), and Barkley (1968).